AN ILLUSTRATED GUIDE TO THE IDENTIFICATION OF SOME MARKET DISORDERS OF HEAD LETTUCE

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An Illustrated Guide to the Identification of Some Market Disorders of Head Lettuce

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INTRODUCTION

Head lettuce is subject to many market disorders, some of which are easily confused because their symptoms closely resemble each other. This confusion presents difficulties at market inspections, when accurate identification is needed to help avoid or settle disputes.

This publication is designed primarily to aid in the identification of various disorders of lettuce, with precise descriptions and illustrations of each. Diseases caused by fungi and most bacteria are not included, with the exception of bacterial soft rot. The early symptoms of bacterial soft rot are included because they resemble those of russet spotting.

The Appendix lists pertinent source material that generally is available in agricultural libraries and addresses of some Federal and State agencies concerned with inspection, research, and extension activities related to market disorders of head lettuce.

CARBON DIOXIDE INJURY

Lettuce may be injured when carbon dioxide (CO_2), a product of normal respiration, accumulates in the load compartment of railcars or trailers.

BROWN STAIN

One form of CO_2 injury consists of distinct lesions that have been termed "brown stain". Typical lesions average about ¼ inch wide and ½ inch long and have distinct margins that often are darker than the slightly sunken centers of the lesions. The dark margins produce a halo effect (pl. 1). Brown stain occurs on both leaf surfaces, often on or near the midrib and toward the base of a leaf. Lesions commonly develop on several head leaves just under the cap leaves, but also may develop on leaves deeper in the head. The heart and wrapper leaves are not affected by brown stain.

Young lesions appear water-soaked, but old ones may become tan, brown, or even black. When CO_2 injury is severe, the brown stain lesions may

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coalesce and thus be several inches long (pl. 2).

Brown stain lesions occasionally resemble russet spotting (compare pls. 3 and 15). When this occurs, the two disorders sometimes can be distinguished by examining the heart leaves. Although the heart leaves show neither type of spotting, they may have reddish-brown margins or be completely discolored when excess CO_2 is the cause of the injury. If the heart leaves are normal, no positive identification is possible unless there are typical brown stain symptoms (pl.1) present on other heads in the same lot.

HEART LEAF INJURY

Heart leaves injured by CO_2 have reddish-orange margins, or the entire leaf may be discolored (pl. 4). This symptom is more frequent and more serious in soft heads than in firm or hard heads. In soft heads the margins of the inner, green head leaves also may be discolored, but they usually become grayish rather than reddish orange.

Susceptible lettuce sometimes can be injured by exposure to only 1 percent CO_2 for 1 week at 35° F., but serious injury more often occurs when the CO_2 concentration is above 2 percent. Such concentrations have been observed in transcontinental shipments of lettuce. CO_2 combined with oxygen (O_2) levels below 5 percent is more injurious than CO_2 alone. When the transit period is extended to 1 month, as in export shipments, 2 percent CO_2 can cause serious injury at either normal or low O_2 levels.

LOW-OXYGEN INJURY

Low O_2 injury is confined to lettuce shipped under improperly adjusted atmospheres or under conditions in which gas exchange is severely restricted.

Wrapper and cap leaves affected with low O_2 injury have shiny to water-soaked gray, dead patches (pl. 5 and 6). Young head leaves sometimes have shallow reddish-brown spots on the midribs, usually on the inner (adaxial) surface. The youngest heart leaves are reddish brown (pl. 7). Discolored heart leaves usually are the first visible symptom of low O_2 injury, sometimes the only symptom.

A flat, sweet flavor accompanies low O_2 injury, but this off-flavor disappears almost completely within 3, possibly fewer, subsequent days in air.

At common transit temperatures (38° ± 2° F.) lettuce can be severely injured during 1 week in ¼ percent O_2 or less. However, at higher temperatures O_2 levels near ½ percent can be injurious.

INTERNAL RIB NECROSIS
(Blackheart, Gray Rib, Gray Streak, Rib Blight)

Internal rib necrosis occurs sporadically during the winter harvest season in the desert valleys of Arizona and California. The cause of internal rib necrosis has not been determined; however, the disorder appears to be limited to the cultivar Climax and closely related strains of lettuce.

Internal rib necrosis appears as a diffuse, dark, gray-green, or occasionally coal-black, discoloration of the lower midrib (pls. 8 and 9). Symptoms normally are most distinct on the outer head leaves and some of the smaller inner leaves (pl. 10) but occasionally appear on the wrapper leaves. Normally,

the lesions are elongate and may extend 3 to 4 inches along the midrib. The necrotic area first appears in the midrib tissue near the point where it joins the stem. The disorder does not affect the surface or epidermal tissues except in severe cases.

Temperatures at which lettuce normally is shipped neither promote nor retard the disorder.

PINK RIB

Pink rib occurs most commonly in hard to overmature lettuce, but can affect less mature heads.

Pink rib is characterized by a diffuse, pink discoloration near the bases of midribs of the outer head leaves (pl. 11). The discoloration usually is most intense on the inner (adaxial) surface, but it often can be seen from the outer (abaxial) surface. In heads with severe symptoms all but the youngest head leaves may be pink, and the discoloration may reach into the large veins. Even the wrapper leaves may be affected.

Causes of pink rib have not been identified; however, unfavorably high temperatures in transit or storage accelerate its development. Holding lettuce in low O_2 atmospheres can accentuate pink rib during 1 week at an undesirably high temperature (50° F.) or during 1 month at low temperature (36°).

RIB DISCOLORATION
(Rib Blight, Brown Rib)

Rib discoloration occurs primarily during the warm part of the growing season on the inner (adaxial) surface of outer head leaves and most commonly at the curvature of the midrib where veins branch off (pl. 12). Wrapper or cap leaves are rarely affected. Discolored areas usually are on the midribs and are oblong, yellowish tan at first, and brown or black later. The areas between the very dark tissue may be discolored in severe cases. The discoloration does not materially expand after harvest. When viewed from the outer (abaxial) surface, rib discoloration resembles internal rib necrosis, but is nearer where the midrib broadens into the leaf blade (pl. 13).

The cause of rib discoloration is unknown, but high temperatures during growth seem to favor its development.

RUSSET SPOTTING

Russet spotting occurs most commonly during March in desert-grown lettuce and in September or October in lettuce from the coastal valleys of California.

Russet spots may occur anywhere in a head, except on the heart leaves. The spots are small, tan, russet-brown, or olive (pl. 14). They are mostly on the midrib, but may develop on other parts of a leaf (pl. 15). On the midrib, the spots are pitlike; on the blade, they are more shallow, more rounded, and diffuse. On the blades, the spots may be either on the veins or between them.

Most spots occur as depressions of the surface cells, but some occur below the surface. The latter appear diffuse and dark below the surface layers of normal white cells in the ribs and large veins.

Exposure of lettuce to ethylene is an important cause of russet spotting.

Thus, shipping or storing lettuce with crops that produce ethylene, such as melons, strawberries, apples, or pears, can cause serious spotting unless temperatures are continuously below 36° F.

Russet spotting also may develop without exposure to ethylene if the heads are overmature; if shipped or stored at 38° F. or higher; if stored for 10 days or more; or if exposed for 2 or more consecutive days to temperatures above 86°, 9 to 14 days before harvest.

RUSTY-BROWN DISCOLORATION (Formerly Rusty Rib)

Rusty-brown discoloration has been observed only in the cultivar Climax, which is widely grown in the desert areas of Arizona and California. Consequently, the disorder has occurred mainly in winter and early spring lettuce. Hard heads are much more susceptible to this disorder than soft or firm heads. The disorder originates in the field, but becomes serious only after harvest.

In heads with rusty-brown discoloration, the midribs of leaves (pl. 16) or the entire leaves (pl. 17) may be discolored. The discoloration tends to follow the veins, but is not confined to them (pl. 17). In some cases, the veins may be normal and the interveinal tissue discolored.

Although the entire head may be affected by this disorder, in most cases only leaves in the outer half of a head are discolored (pl. 18, reddish discoloration). Dark discoloration near the base of the head is internal rib necrosis.

Distinct, sunken lesions are present in severe cases only. Usually, only the epidermis and one to four adjacent cell layers are affected.

The cause of rusty-brown discoloration has not been determined. The disorder develops rapidly in heads held 1 week at 32°, 36°, or 41° F. but is less severe at 50°. Thus, undesirably high storage temperatures are not a causal factor.

BACTERIAL SOFT ROT

Bacterial soft rot is included in this publication only because the early symptoms are sometimes confused with russet spotting. Lesions are small, tan to brown, and slightly elongated (pl. 19). They may occur on any part of the leaf, and obviously decayed tissue often is in the vicinity or on adjacent leaves.

Bacterial soft rot can be distinguished from russet spotting by a combination of the following characteristics:

Characteristic	*Bacterial soft rot*	*Russet spotting*
Color	Tan to brown	Tan, brown, olive.
Shape	Mostly elongated	Irregular.
Surface	Glistening; always sunken; epidermis always affected.	Dull; not always sunken; epidermis not always affected.
Other	Frequently associated with internally discolored veins; obviously decayed tissue often in vicinity or on adjacent leaf.	Veins not discolored internally; not associated with decayed tissue.

Occurrence and causal factors for bacterial soft rot are not within the scope of this publication. These topics are covered in the publication by Ramsey, Friedman, and Smith, listed under Source Material.

APPENDIX

SOURCE MATERIAL

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ADDRESSES

U.S. Department of Agriculture, Agricultural Research Service Laboratories

Eastern Market Pathology Laboratory
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Plate 1.—Carbon dioxide injury. Brown stain, individual lesions.

Plate 2.—Carbon dioxide injury. Brown stain, coalesced lesions.

Plate 3.—Carbon dioxide injury. Brown stain resembling russet spotting.

Plate 4.—Carbon dioxide injury. Discolored heart leaves.

Plate 5.—Low-oxygen injury on wrapper leaves.

Plate 6.—Low-oxygen injury on wrapper leaf, detail.

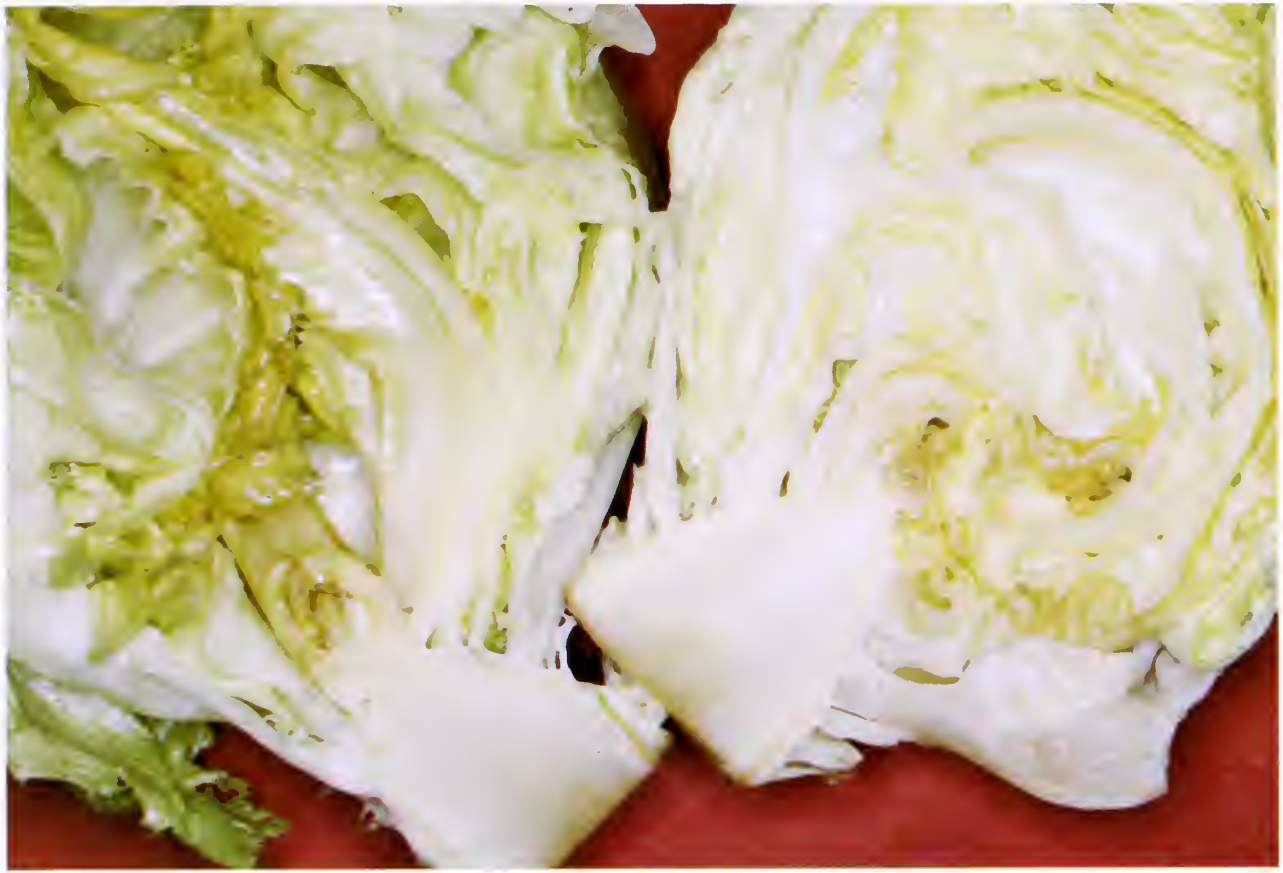

Plate 7.—Low-oxygen injury. Discolored heart leaves.

Plate 8.—Internal rib necrosis. External view of head.

Plate 9.—Internal rib necrosis. Detail of midrib.

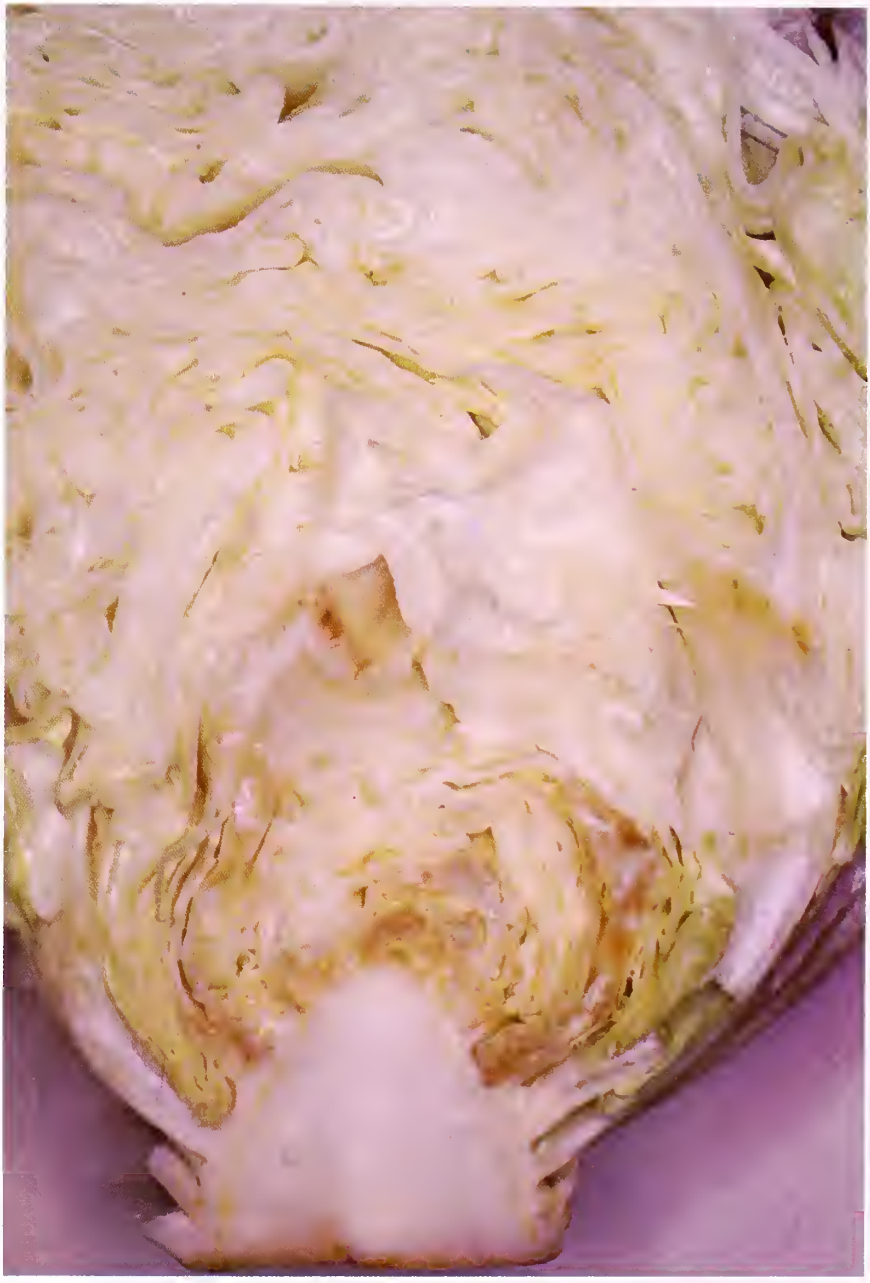

Plate 10.—Internal rib necrosis. Cross-section of affected head.

Plate 11.—Pink rib.

Plate 12.—Rib discoloration on inner leaf surface.

Plate 13.—Rib discoloration on outer leaf surface.

Plate 14.—Russet spotting. Entire head.

Plate 15.—Russet spotting. Individual leaf.

Plate 16.—Rusty-brown discoloration. Head, bottom view.

Plate 17.—Rusty-brown discoloration. Head, top view.

Plate 18.—Rusty-brown discoloration. Cross-section of head (reddish discoloration).

Plate 19.—Bacterial soft rot. Section of midrib.

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